

Laparoscopy at sea: *Overcoming unique challenges*



by

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Surgical procedures may be performed aboard several different classes of U.S. Navy vessels. The most advanced are the two hospital ships, the USNS *Mercy* and the USNS *Comfort*. These ships are essentially floating 1,000-bed hospitals with fully manned 12-room operating suites. There is arguably little difference between medical care rendered here and in civilian hospitals. However, the aircraft carriers and amphibious assault ships represent more austere environments in which performing operations is possible but with certain limitations.

The aircraft carrier's mission is to provide forward deployed offensive capability. Surgical support, including one operating room and three intensive care beds, is intended only for the crew of the ship and the surrounding support ships in the carrier battle group. Amphibious assault ships are either LHA class (general purpose) or LHD class (multi-purpose). The LHD class is newer and larger with six operating rooms and 17 intensive care beds. However, the medical manning is identical to the LHA class. The amphibious assault ship travels in an amphibious readiness group (ARG), which typically includes at least two other ships. The ARG transports and supports a Marine expeditionary unit, along with all of their equipment and aircraft. Similar to the carriers, the amphibious ships provide medical support to their crew and to the smaller ships traveling with them. However, the main reason these ships have surgical capability is to care for the U.S. Marines who may become injured ashore during their missions.

The USS *Tarawa* is an example of an LHA class, and is where the subsequently described procedures were performed. The LHA class has four operating rooms, of which two are typically functional. The ship deploys with a general surgeon, nurse anesthetist, two primary care physicians, several general medical officers, an operating room nurse, and a critical care nurse. Additionally, approximately 30 hospital corpsmen fill roles in various areas including the pharmacy, preventive medicine, X-ray technology, the laboratory, the blood bank, surgical technology, and medical records administration. During times of conflict, additional personnel may be added, including general surgeons, orthopaedic surgeons, anesthesiologists, intensivists, nurses, and corpsmen.

The operating rooms are equipped with modern anesthesia and monitoring equipment, along with most instruments required for general, vascular, and thoracic operations. Basic orthopaedic and neurosurgical instruments are also available. The OR houses a laparoscopic tower with camera, light source, insufflator, and monitor. The USS *Tarawa* was fortunate to have both 0° and 30° 5-mm and 10-mm laparoscopes, along with two reusable 5-mm working ports. Laparoscopic instruments included several graspers, two Maryland-type dissectors, scissors, and a 10-mm stone scoop (see Figure 1, page 14). Several disposable 5-mm and 10-mm working ports were procured before departure.

The table on this page lists the procedures performed on the USS *Tarawa* during four months of its 2003 western Pacific deployment, which included participation in Operation Southern Watch and Operation Iraqi Freedom. The following cases are representative and illustrate how certain unique challenges may be overcome.

Case number one

An 18-year-old female presented to the medical officer on a nearby ship with severe left lower quadrant pain. A white blood cell count was taken and was normal. She was diagnosed with gas pain and given an injection of ketorolac. This treatment provided only minimal relief, and she was flown to the USS *Tarawa* for surgical evaluation. On arrival, the pain had been present for 15 hours and was unrelenting. Examination revealed evidence of peritoneal irritation and she was taken emergently to the operating room. The presence

Laparoscopic procedures performed at sea

| Procedure | Number |
|------------------------|--------|
| Appendectomy | 4 |
| Cholecystectomy | 3 |
| Inguinal hernia | 4 |
| Salpingo-oophorectomy | 1 |
| Varicocele ligation | 3 |
| Diagnostic laparoscopy | 1 |

of a 7-foot swell required the surgical team to take some extra measures in securing all equipment and the patient (see Figure 2, page 15). A laparoscope was placed via a 10-mm working port at the umbilicus. Abdominal visualization quickly demonstrated the problem, which was an ovarian torsion secondary to a 4-cm cyst. Five-mm working ports were placed on either side of the lower abdomen. The point of torsion involved the Fallopian tube and proper ovarian ligament. An 0-Chromic suture was tied intracorporeally just proximal to the torsion using two Maryland dissectors. An 0-Vicryl suture ligature was then placed past the tie, using the Maryland dissector as a needle driver. The tube and ovary were then excised and placed into a plastic sandwich bag, which had been previously sterilized in activated dialdehyde solution. This facilitated removal from the 10-mm umbilical port with minimal enlargement. The patient had only slight incisional pain after surgery. She was observed on the ward until postoperative day two, when her pain was controllable with only ibuprofen. She was flown back to her ship on day four and returned to work on postoperative day six.

Case number two

A 30-year-old male was seen at a Kuwaiti hospital for right upper quadrant pain. A mildly increased bilirubin was noted, and an ultrasound demonstrated gallstones with a thickened gallbladder wall and a normal common bile duct. Laparoscopy was not available locally, and he was flown to the USS *Tarawa* in the Northern Arabian Gulf. Laparoscopic cholecystectomy was performed routinely, although lack of a clip applier or cholangiogram catheter required some modifications. The cystic duct was dissected free and tied-off just under Hartmann's pouch with



Figure 1. Laparoscopic instruments available aboard USS *Tarawa*.

an 0-Chromic tie. The cystic was then partially incised and a grasper was used to “milk back” bile from the common bile duct. The presence of free-flowing golden bile without debris gave some reassurance that common duct stones were not present.

The cystic duct stump was then tied off with a pair of 2-0 silks. The cystic artery was tied off with a 2-0 silk proximal and cauterized distally. Because of the theoretic concern of a power density being created at the tie when cautery is used in this fashion, it was applied to the individual branches just off the gallbladder. The rest of the procedure was performed routinely. The patient was observed for four days on the ward, at which time he required only ibuprofen for pain relief. He was returned to full duty on postoperative day eight.

Case number three

A 21-year-old male with three weeks of left inguinal pain and bulge was transferred from another ship for evaluation. He had a history of



Figure 2. Securing of the laparoscopic tower during heavy seas.

bilateral inguinal hernia repair at age two. Examination revealed a moderate-size left inguinal hernia. He was taken the next day for laparoscopic bilateral hernia repair. Neither a balloon dissector nor Hasson canula were available. A purse-string suture was placed in the anterior rectus fascia and generous finger dissection was performed. A 10-mm disposable port, which had been salvaged and resterilized, was then tied in with the purse string. The laparoscope and insufflation were used to create the preperitoneal working space. Five-mm ports were then placed into this space from either side of the lower abdomen. Dissection was performed routinely and a moderate-size left indirect hernia was reduced. Two separate pieces of 12-cm \times 10-cm polypropylene mesh were fashioned

with a slit and passed into the abdomen to cover either myopectineal orifice. A clip applicator was unavailable; therefore, a 2-0 Vicryl suture was used to fix the two pieces of mesh together in the midline at two places, as well as gently tacking them to the anterior rectus muscle fibers (Figure 3, page 16). Dessufflation was performed under direct vision to assure the mesh remained in position. He was returned to his ship on post-operative day four and resumed full duty the next day taking only ibuprofen.

Case number four

A 22-year-old male was transferred from a nearby ship with a painful scrotal mass. Examination revealed a left, grade III varicocele. An inguinal approach would require a Doppler probe, which was unavailable. However, a Medline search revealed several series reporting excellent results with a laparoscopic approach.^{1,2} I explained to the patient that I had no experience with varicocele surgery, but was confident a laparoscopic approach could be performed safely. He did not want to be evacuated from the theater of operations and elected to proceed.

He was given general anesthesia, and the abdomen was insufflated with a Veress needle. A 5-mm laparoscope was placed at the umbilicus, and 5-mm ports were placed on either side of the lower abdomen. Visualization revealed the left gonadal vessels to be somewhat dilated compared to the right. Additionally, he had a small indirect hernia on the left. The peritoneum was opened above the internal ring as for a transabdominal preperitoneal hernia repair. The hernia sac was reduced and the gonadal vessels were dissected free. Three 2-0 silk ties were placed around the vessels intracorporeally, and they were divided en masse. A 12-cm \times 10-cm polypropylene mesh was then fashioned and passed into the abdomen after removing one of the 5-mm ports. The mesh was tacked to the anterior rectus just above the pubis with a 2-0 Vicryl. The peritoneum was then closed with a running 2-0 Vicryl incorporating the mesh so it would be unlikely to migrate. He had minimal incisional pain postoperatively and returned to work in three days.

Discussion

Laparoscopic surgery may be performed aboard certain U.S. Navy combat vessels. The well-known advantages of a minimally invasive approach become even more profound at sea. Many procedures can be done through 5-mm wounds with truly minimal postoperative pain. At sea, this result is important for several reasons, the most obvious one being that every extra work hour lost degrades the readiness of the ship. Every sailor is critically important to completion of the mission. Extended periods of care not only tie up limited medical resources, but leave the ship understaffed. It has been said that the goal of Navy medicine is to keep as many sailors at as many guns for as many hours as possible.

Along with a finite number of personnel to run the ship, supplies are limited. Patients with requirements for large amounts of pain medicine can quickly deplete stores, with resupply at sea always posing a challenge. The large amphibious ships deploy with a single nurse capable of assisting in postoperative care. There is no patient-controlled analgesia, and, needless to say, a patient requiring around-the-clock morphine injections can create a problem. Our ward nurse, previously unimpressed with laparoscopy, soon became its biggest advocate.

Probably the hardest adjustment for a young surgeon, trained with unlimited access to modern diagnostic tests and imaging modalities, is being forced to make decisions based on physical exam and basic blood work. Evacuation to a hospital is occasionally impossible. When land is within reach, it is often foreign soil where the health care standards are not as high as those of the U.S. Medical evacuation also requires a ride in at least one helicopter, which can present its own health risks. All of these factors lower

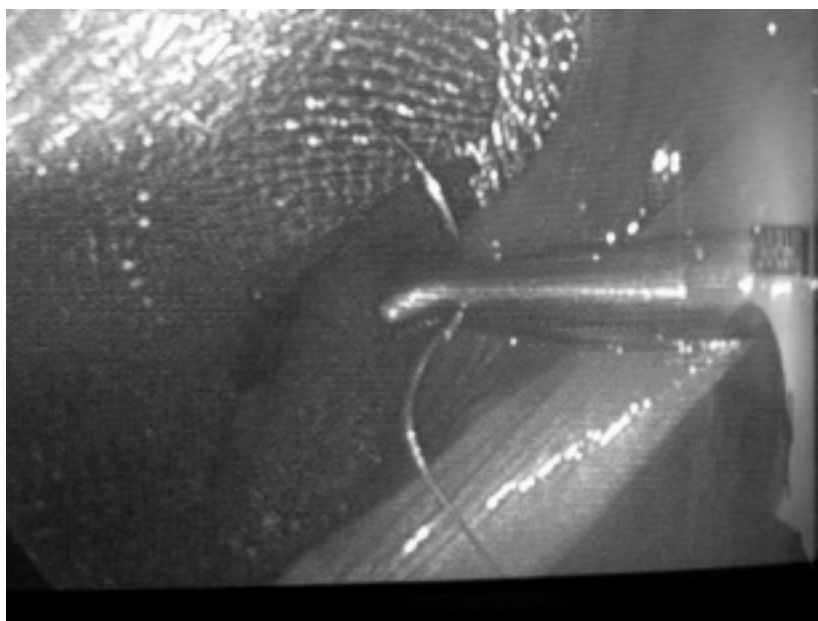



Figure 3. Suturing the two pieces of polypropylene mesh together and to the anterior rectus muscle.

the threshold for performing a diagnostic operation when abdominal pathology is suspected. The entire abdomen can be thoroughly evaluated with three 5-mm incisions. It was my policy to routinely explore the entire abdomen, even when an obvious source was quickly identified. Although the extra probing may slightly increase the risk of the procedure, I believe it is necessary to maximize the accuracy of the only diagnostic modality available. If lower abdominal pain was present, the appendix was routinely removed in the absence of an alternative source. This approach was followed based on at least one series demonstrating the inaccuracy of laparoscopically identifying a normal appendix.³ In three consecutive cases of lower abdominal pain and normal-appearing appendix, the patient was pain-free and back to work within a few days after removal. If unexpected pathology is identified, it can invariably be managed with the laparoscope. The first case described in this article is a good example of diagnostic laparoscopy leading to a therapeutic intervention.

There are also several challenges to performing laparoscopy at sea. By the time we arrived in the Arabian Gulf, the ship's supply of carbon dioxide had been exhausted. An effort to resupply in Singapore had failed. We had to cut through many layers of bureaucratic interference to obtain more. The ship has a large supply of nitrous oxide, which could be used as an alternative if the proper connectors are available.⁴

The second problem is the limited number of instruments. This is really more of an inconvenience. Sewing with a Maryland dissector instead of a needle driver is annoying but possible. Tying vessels and ducts off, rather than clipping, simply takes more time. The second and third cases demonstrate the ability to substitute sutures for clip applicators or tackers. The lack of a suction-irrigator was harder to overcome. Fortunately, the ship machinists were able to construct a primitive 5-mm valved sucker, and irrigant was simply flushed through the working-port CO₂ inlets.

I had anticipated the lack of another surgeon or resident to assist, particularly with the camera, as another possible hurdle to overcome. However, I was pleasantly surprised by the proficiency of several of the Navy corpsmen in assisting. These individuals are enlisted sailors, some only a few years out of high school, with no prior experience in the operating room. They were enthusiastic about participating, and at least as capable as the average second- or third-year resident in terms of their ability to follow with the camera and to hold instruments. They informed me that these tasks are less challenging than playing some of the current video games.

There are several unique challenges to performing laparoscopy at sea in an austere environment. However, the benefits of reduced pain and faster return to full function can significantly and positively impact mission readiness. To provide optimal care, surgeons should become proficient at laparoscopic suturing and intracorporeal tying prior to deployment at sea. There should be a low threshold for performing a thorough diagnostic laparoscopy for acute abdominal pain in this environment. 

The views expressed in this article are those of the author and do not reflect the official policy or position

of the U.S. Department of the Navy, U.S. Department of Defense, or the U.S. government.

References

1. Magharby HA: Laparoscopic varicocelectomy for painful varicoceles: Merits and outcomes. *J Endourol*, 16(2):107-110, 2002.
2. Bebars GA, Zaki A, Dawood AR, et al: Laparoscopic versus open high ligation of the testicular veins for the treatment of varicocele. *J Soc Laparoendosc Surg/Soc Laparoendosc Surg*, 4(3):209-213, 2000.
3. Greason KL, Rappold JF, Liberman MA: Incidental laparoscopic appendectomy for acute right lower quadrant abdominal pain. Its time has come. *Surg Endosc*, 12(3):223-225, 1998.
4. Tsereteli Z, Terry ML, Bowers SP, et al: Prospective randomized clinical trial comparing nitrous oxide and carbon monoxide pneumoperitoneum for laparoscopic surgery. *J Am Coll Surg*, 195(2):173-179, 2002.

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